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(54) **MULTI-POSITION LOAD DETECTION SYSTEMS AND METHODS**

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B66F 9/075 (2006.01)

(52) **U.S. Cl.**
CPC ***B66F 9/0755*** (2013.01); ***B66F 9/07559*** (2013.01); ***B66F 9/20*** (2013.01)

(58) **Field of Classification Search**
CPC B66F 9/0755; B66F 9/20; B66F 9/07559
See application file for complete search history.

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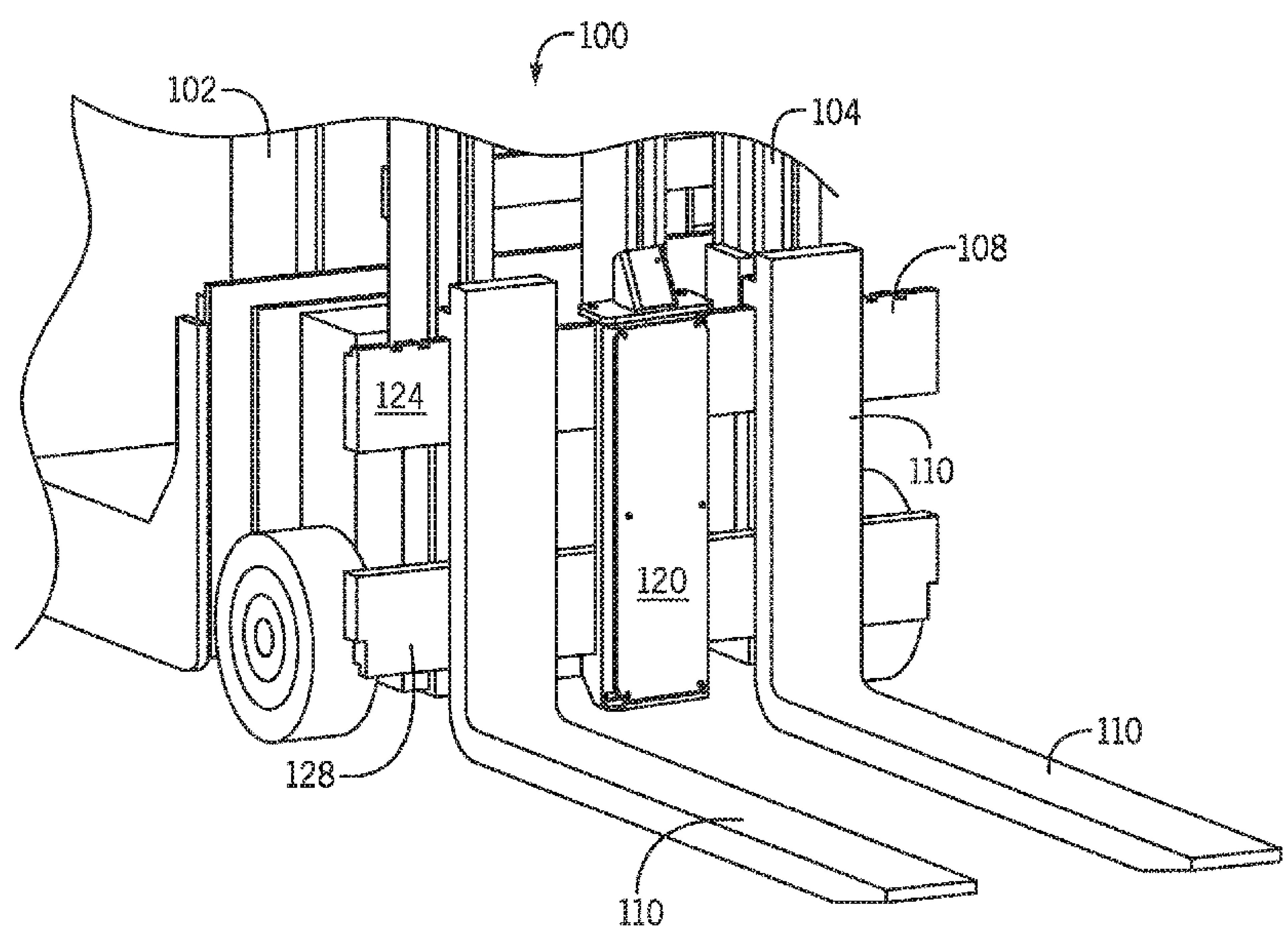
(57) **ABSTRACT**

The present disclosure provides systems and methods for detecting a load on at least one fork of a material handling vehicle. The systems and methods can comprise a housing; at least one sensor positioned within the housing; a sensor arm pivotally coupled to the housing; at least one sensor flag integral with or coupled to the inside of the sensor arm; and wherein when the sensor arm pivots inward toward the housing the at least on sensor flag triggers the at least one sensor to identify at least a first load position and a second load position.

12 Claims, 9 Drawing Sheets



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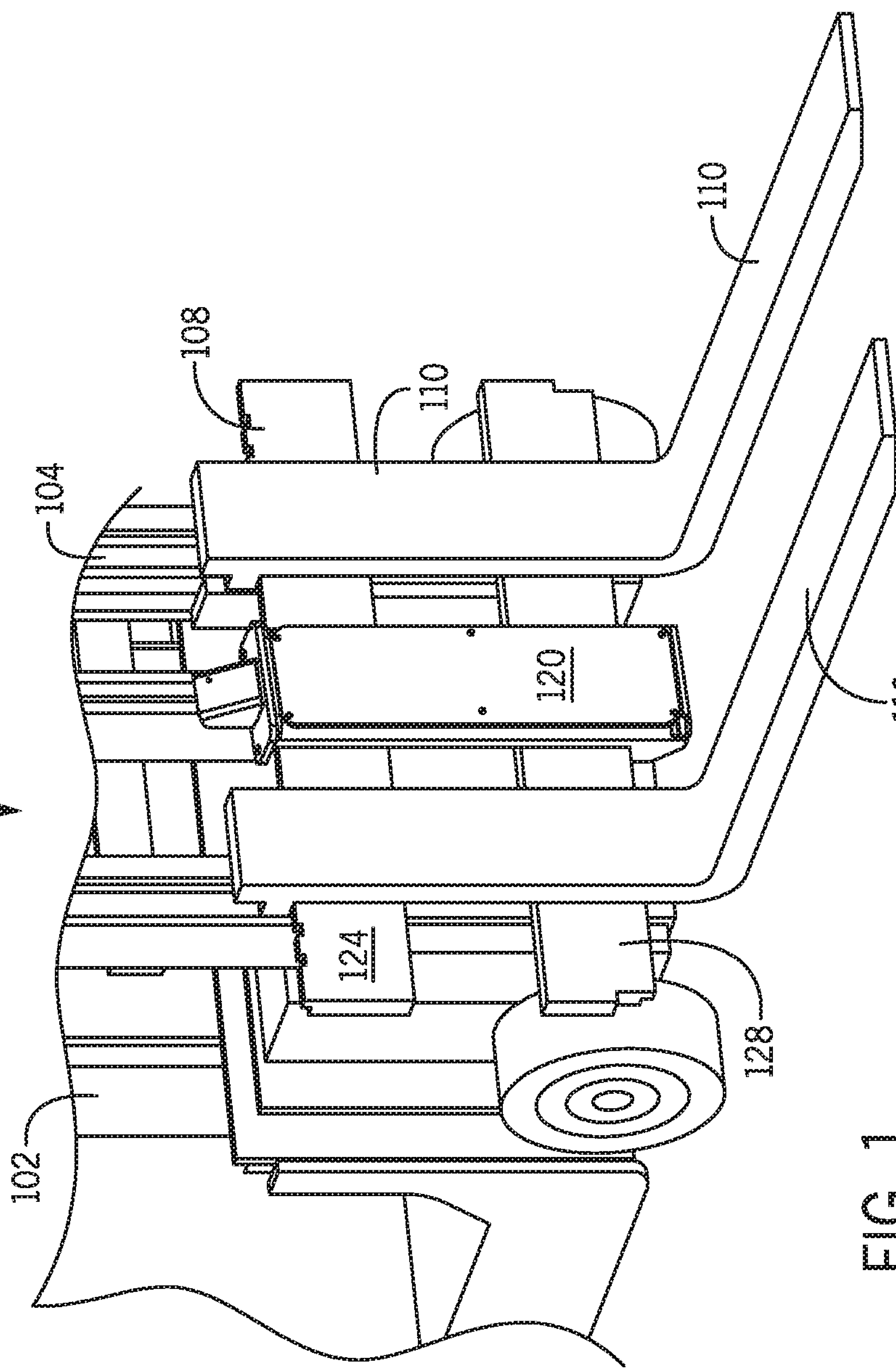

FIG. 1

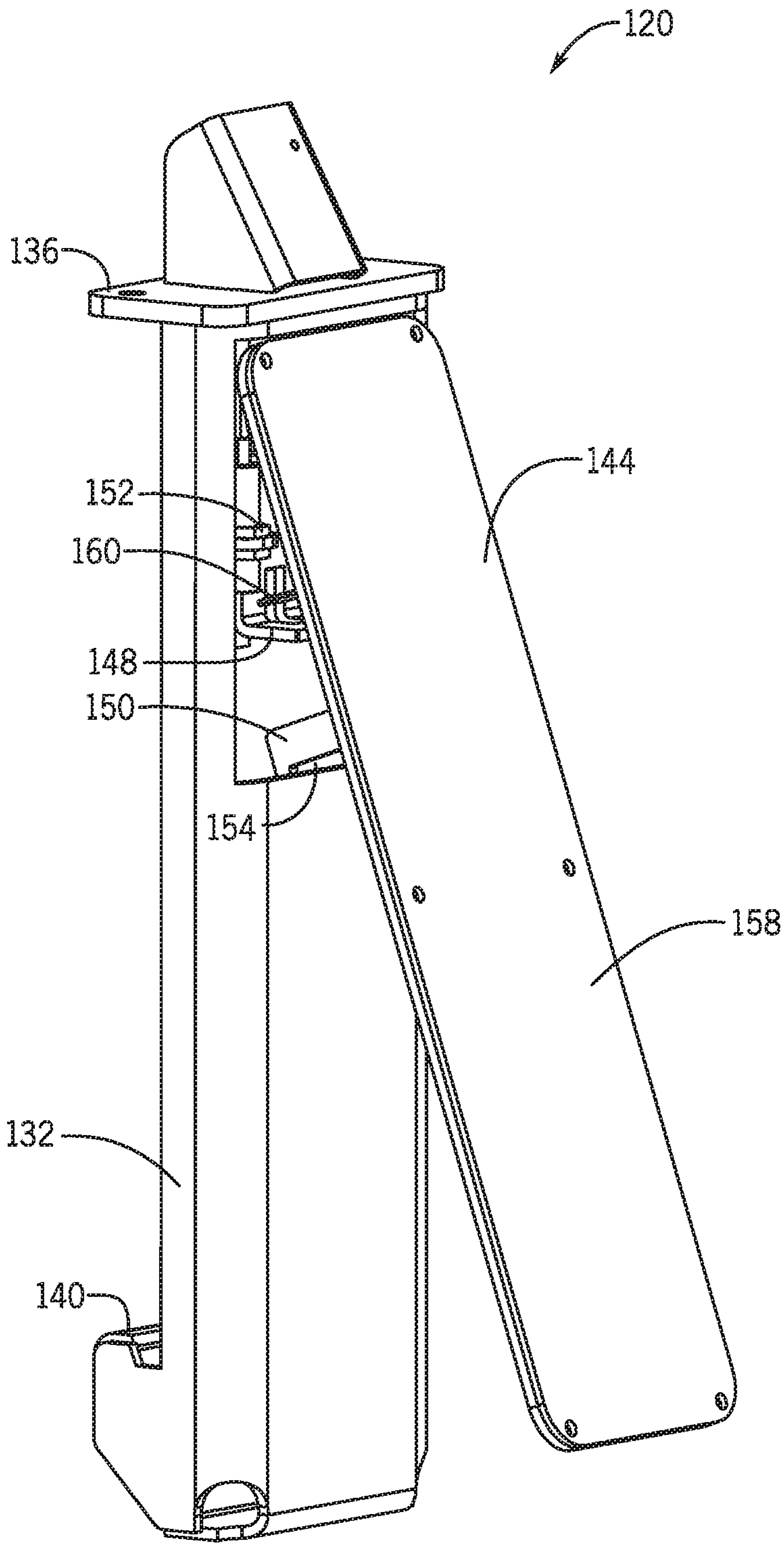

FIG. 2

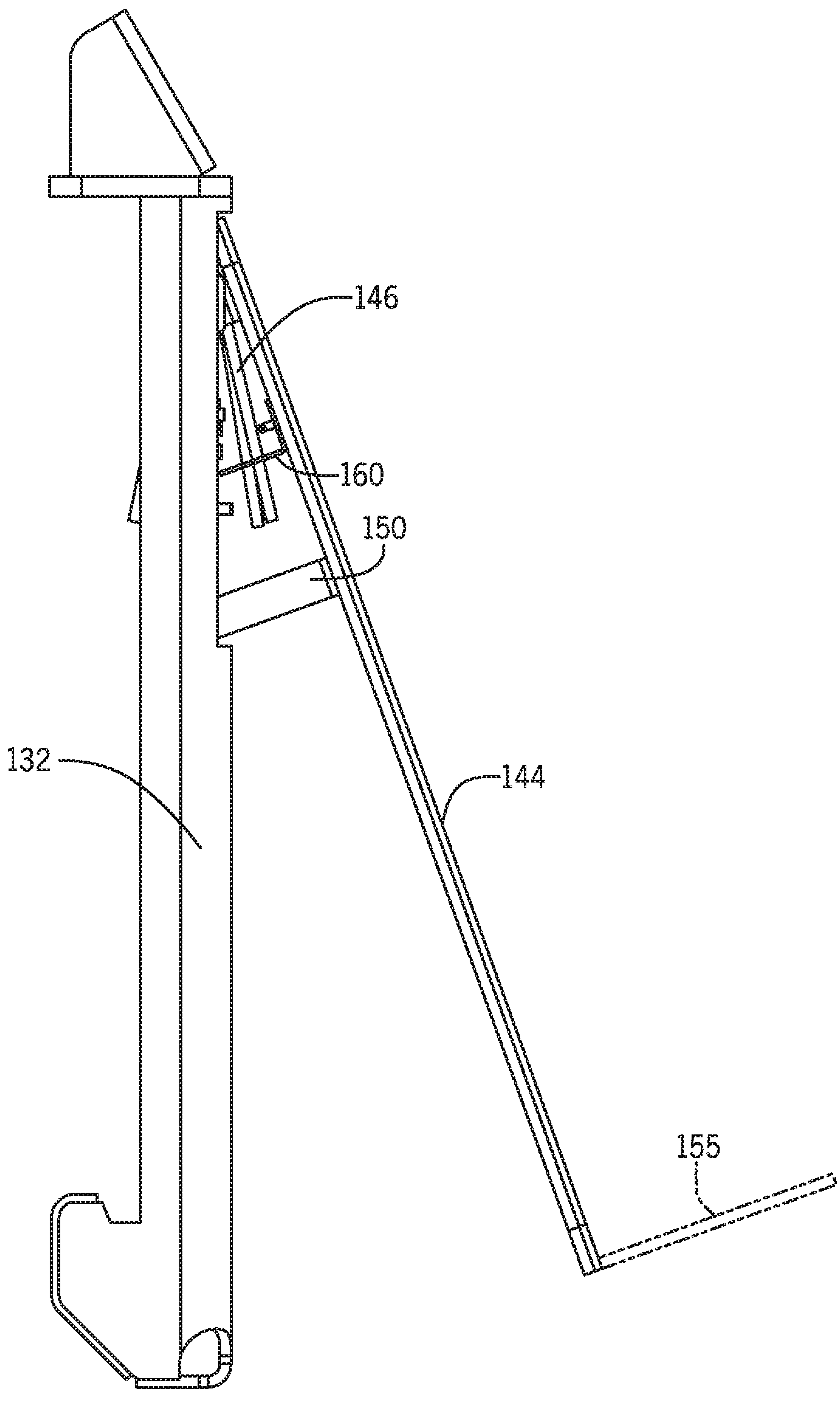

FIG. 3

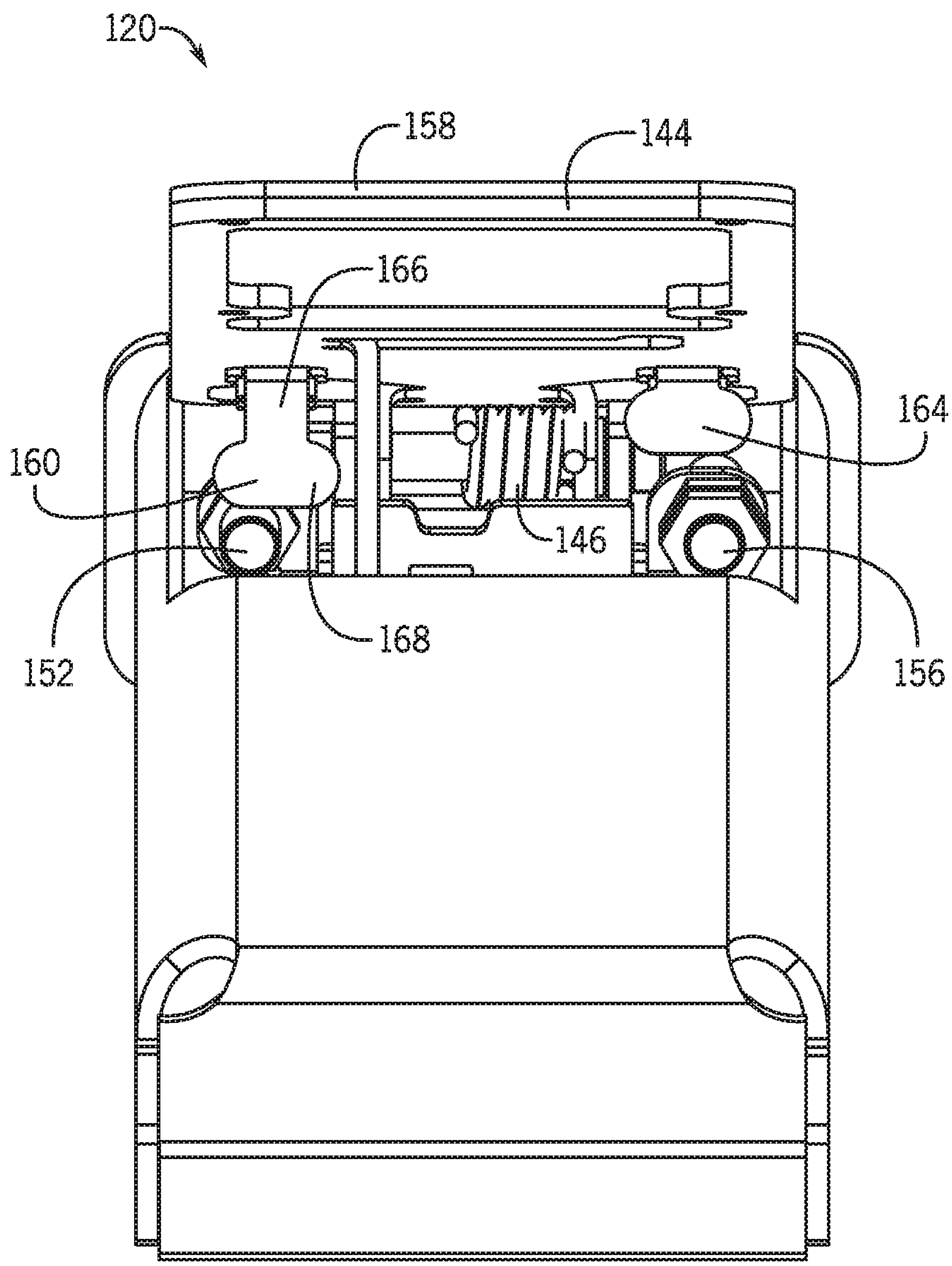

FIG. 4

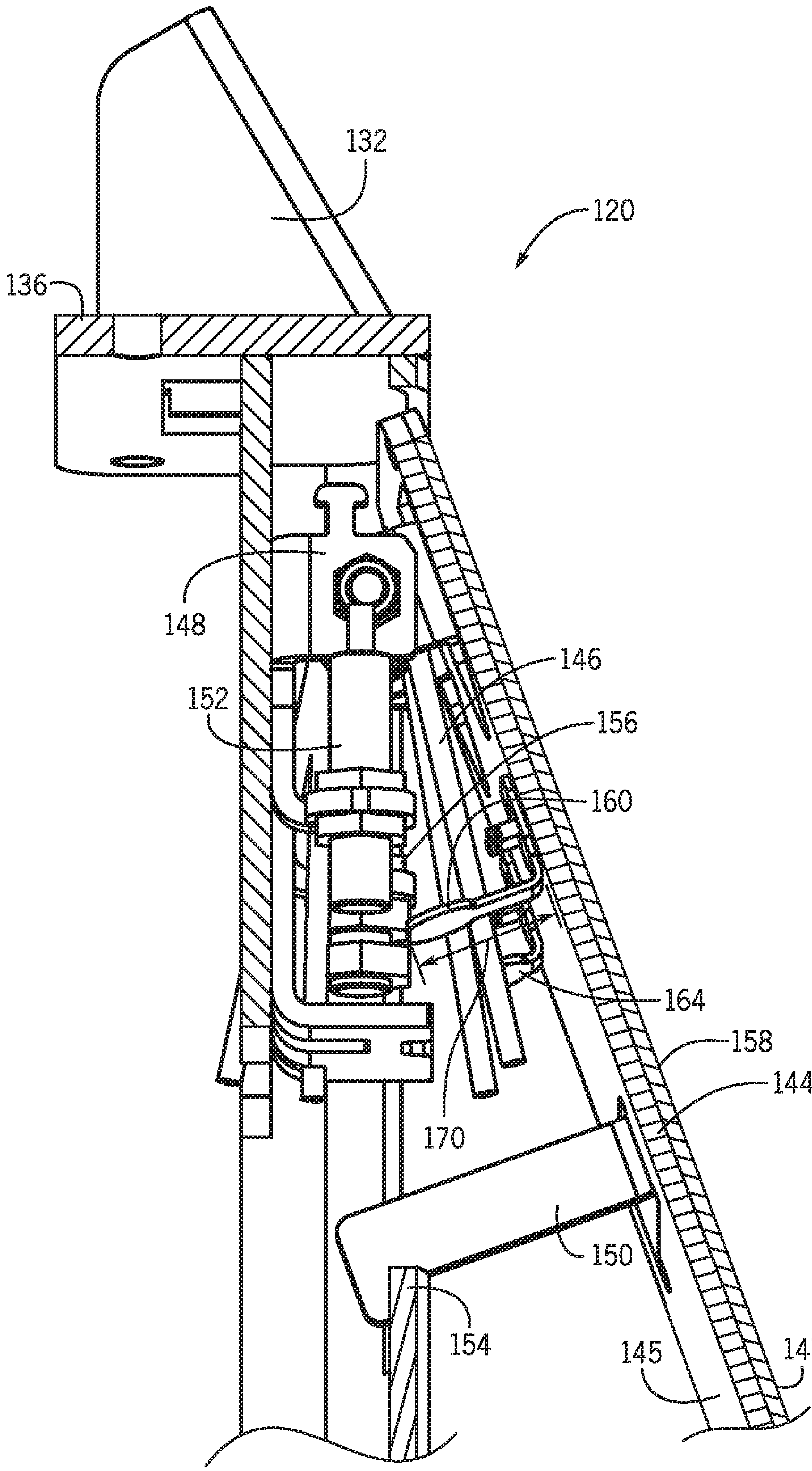

FIG. 5

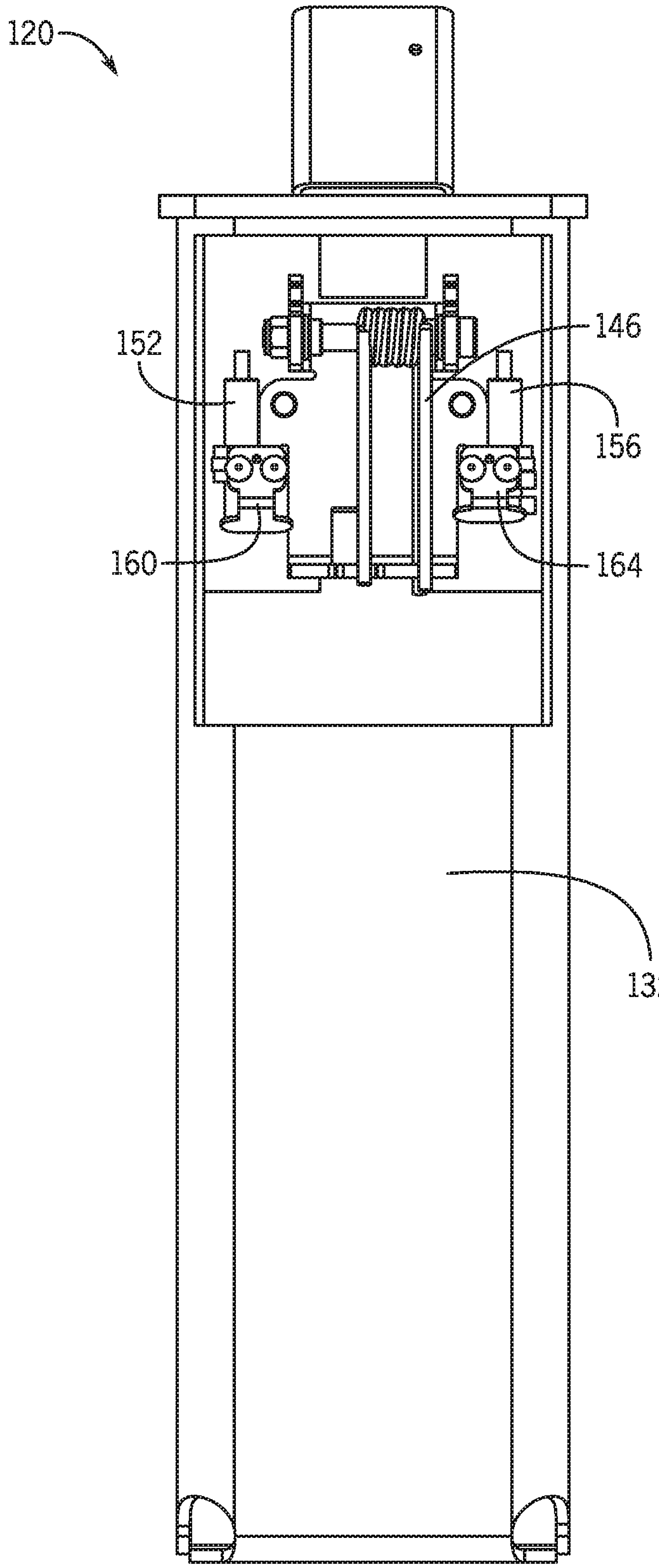

FIG. 6

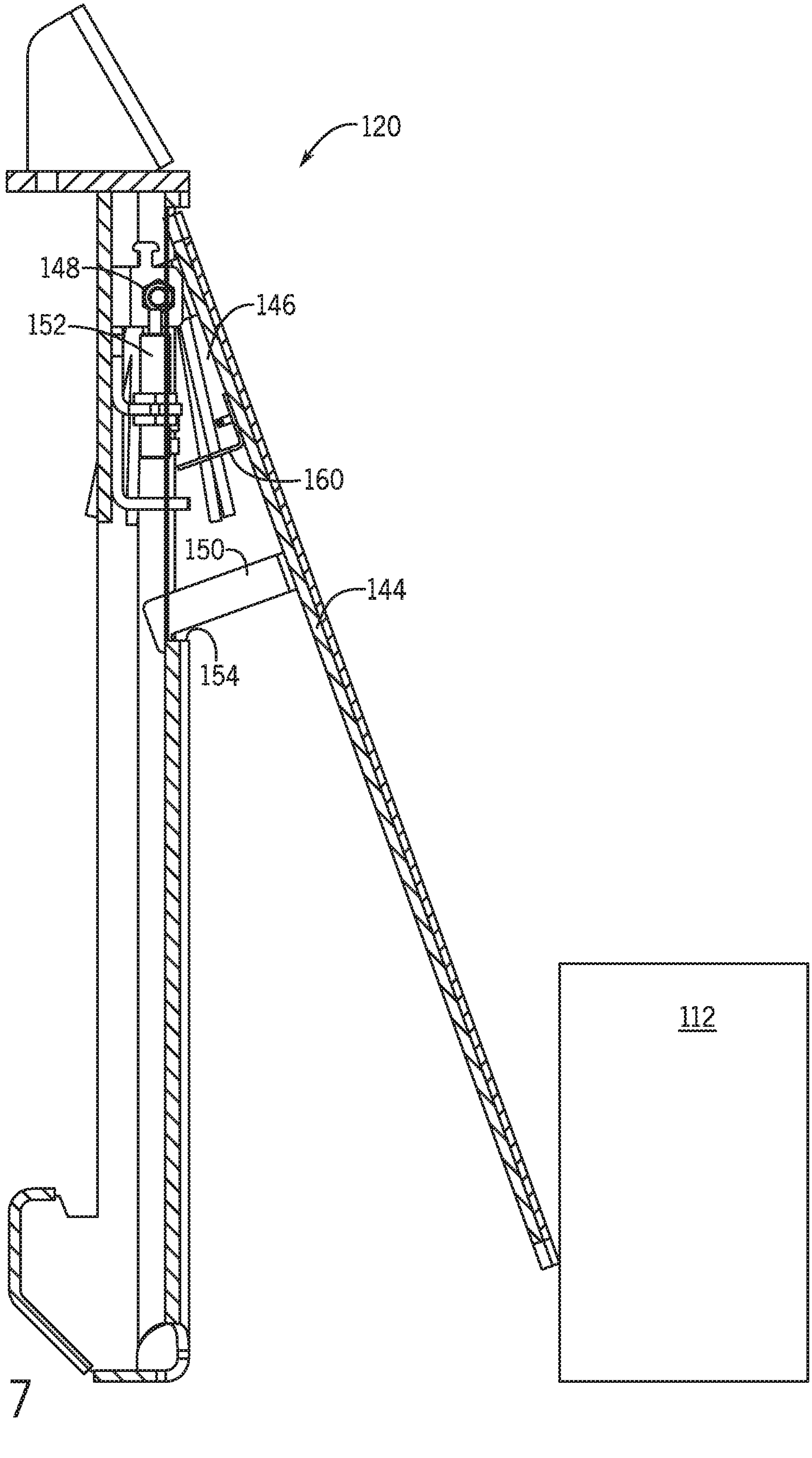

FIG. 7

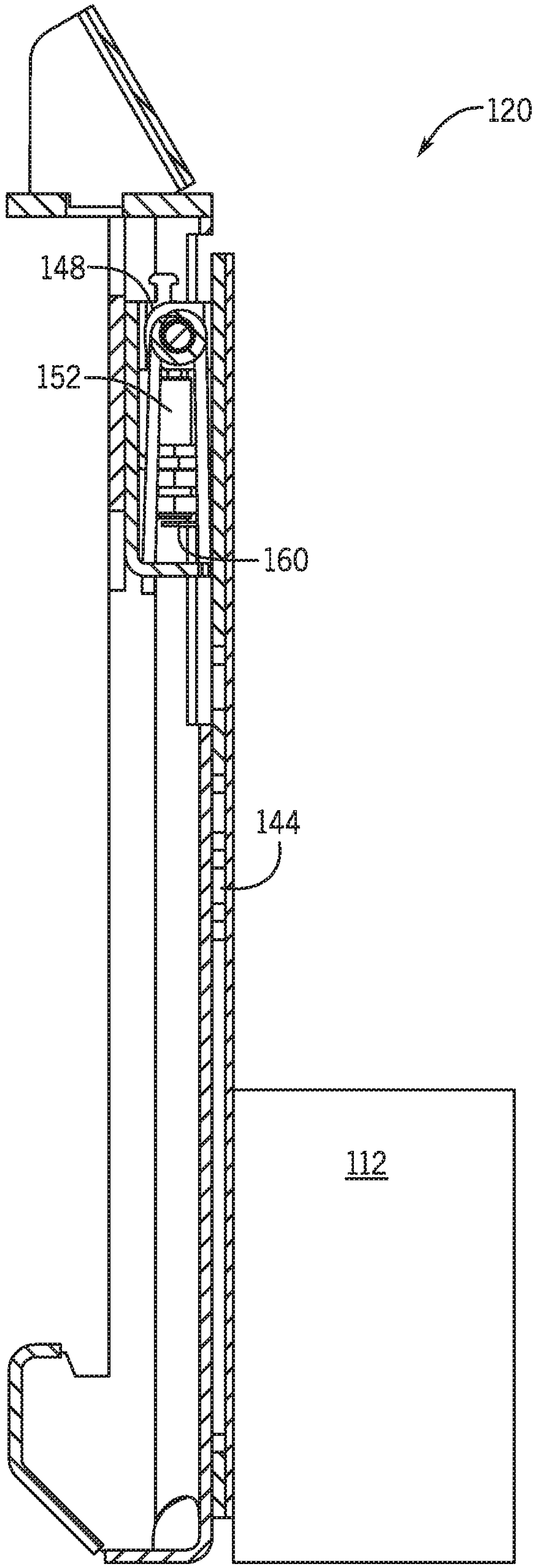

FIG. 8

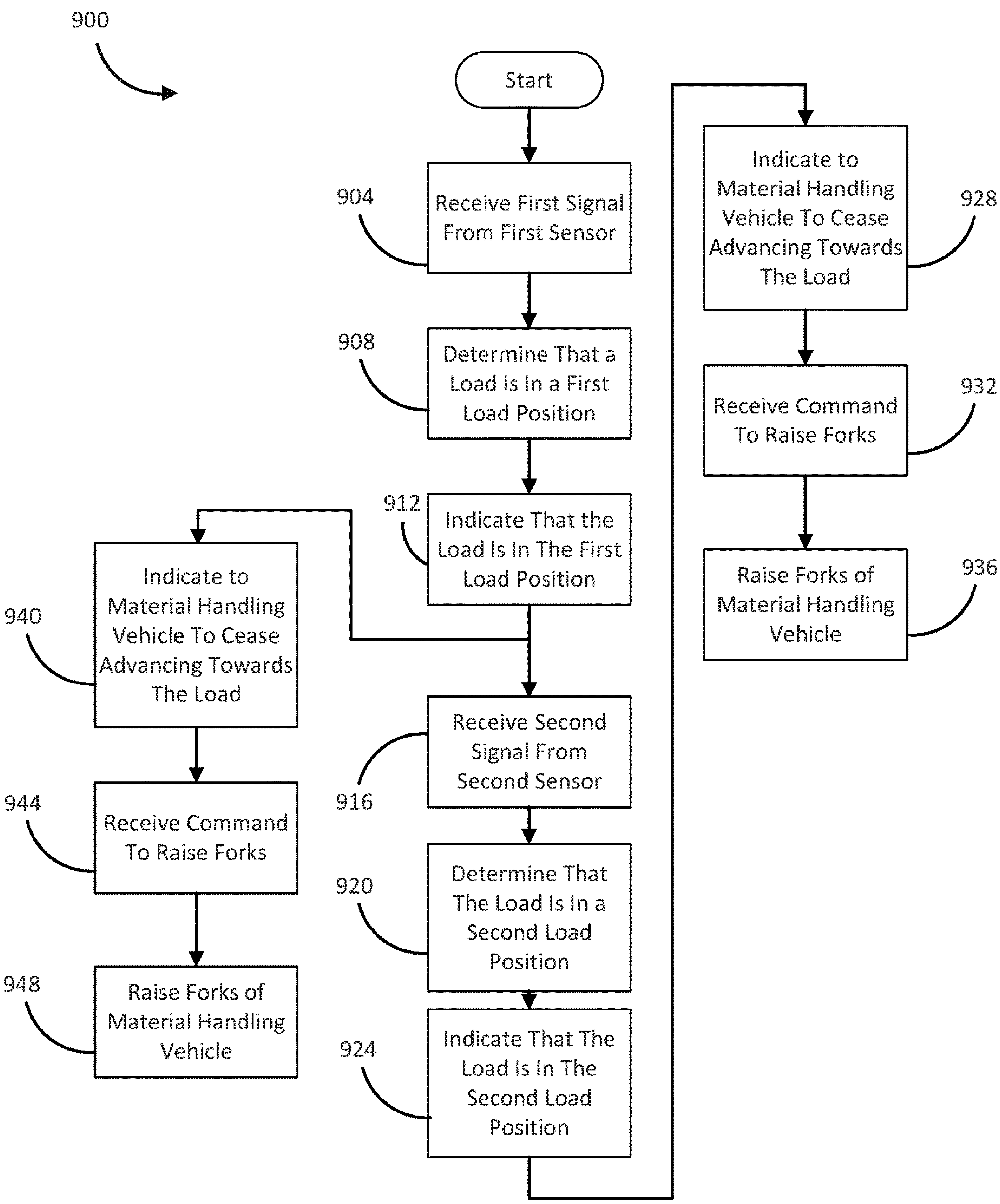
900
Start
904
Receive First Signal From First Sensor
908
Determine That a Load Is In a First Load Position
912
Indicate That the Load Is In The First Load Position
916
Receive Second Signal From Second Sensor
920
Determine That The Load Is In a Second Load Position
924
Indicate That The Load Is In The Second Load Position
928
Indicate to Material Handling Vehicle To Cease Advancing Towards The Load
932
Receive Command To Raise Forks
936
Raise Forks of Material Handling Vehicle
940
Indicate to Material Handling Vehicle To Cease Advancing Towards The Load
944
Receive Command To Raise Forks
948
Raise Forks of Material Handling Vehicle

FIG. 9

MULTI-POSITION LOAD DETECTION SYSTEMS AND MEIHODS

CROSS-REFERENCES TO RELATED APPLICATIONS

The present application is based on, claims priority to, and incorporates herein by reference in its entirety U.S. Provisional Patent Application No. 62/653,914, filed on Apr. 6, 2018, and entitled "Multi-Position Load Detection Systems and Methods."

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

Not Applicable.

BACKGROUND

The present disclosure relates generally to load detection systems and, more specifically, to a multi-position load detection systems and methods for a material handling vehicle.

Material handling vehicles have been developed to transport goods loaded onto generally standardized transport platforms. For example, forklifts are often used to lift goods loaded onto a pallet. Pallets often have vertical supports connected to a top and thus define a channel. Certain known forklifts are configured to approach pallets and insert a two-tined fork into the channel between the vertical support and below the top. The pallet and loaded goods may then be lifted with the forks. The combined pallet and loaded goods may be referred to as a load.

Material handling vehicles commonly use embedded scanners or sensors to determine when a load is positioned on the forks of the vehicle. Other load detection arrangements include use of a unique set of forks with a built-in single position switch to sense when the load is in a specific position on the forks.

These previous methods only allow for one sensing range, which only indicates when a load is in one specific position. When the load has a unique shape, the previous methods may not accurately sense the specific position of the load on the forks. Furthermore, load detection arrangements that use laser scanners to detect a location of a load can incorrectly sense debris along a warehouse floor as being a load, or fail to be triggered by loads with damaged pallets.

BRIEF SUMMARY

In one aspect, the present disclosure provides a system for detecting a position of a load on at least one fork of a material handling vehicle. The system can comprise a housing coupled to a carriage of the material handling vehicle, and the at least one fork coupled to the carriage, a first sensor positioned within the housing, a second sensor positioned within the housing, a sensor arm pivotally coupled to the housing, a first sensor flag extending from the sensor arm for a first activation distance, a second sensor flag extending from the sensor arm for a second activation distance. The sensor arm is configured to pivot a first distance inward toward the housing and the carriage and cause the first sensor flag to trigger the first sensor to indicate a first load position. The sensor arm is further configured to pivot a second distance inward toward the housing and the carriage and cause the second sensor flag to trigger the second sensor to indicate a second load position.

In another aspect, the present disclosure provides a system for detecting a position of a load on at least one fork of a material handling vehicle. The system can comprise a housing, with a sensor positioned within the housing and a sensor arm pivotally coupled to the housing. A sensor flag can extend from an inside of the sensor arm and extend away from the inside of the sensor arm for an activation distance, the sensor flag comprises a neck portion extending from a first end at the inside of the sensor arm and a head portion extending from a second end of the neck portion opposite the first end, the head portion being wider along the activation length than the neck portion.

In another aspect, the present disclosure provides a method in a data processing system comprising at least one processor and at least one memory, the at least one memory comprising instructions executed by the at least one processor to implement a load detection system in a material handling vehicle. The method can include the steps of receiving a first signal from a first sensor on the material handling vehicle; determining that a load is in a first position on forks of the material handling vehicle based on the first signal; indicating to at least one of an operator or a warehouse management system that the load is in the first position on the forks; receiving a second signal from a second sensor on the material handling vehicle after the first signal; determining that the load is in a second position on the forks of the material handling vehicle based on the second signal; and indicating to the at least one of the operator or the warehouse management system that the load is in the second position on the forks.

The foregoing and other aspects and advantages of the disclosure will appear from the following description. In the description, reference is made to the accompanying drawings which form a part hereof, and in which there is shown by way of illustration a preferred configuration of the disclosure. Such configuration does not necessarily represent the full scope of the disclosure, however, and reference is made therefore to the claims and herein for interpreting the scope of the disclosure.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be better understood and features, aspects and advantages other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such detailed description makes reference to the following drawings.

FIG. **1** is a pictorial view of a material handling vehicle with a load detection assembly according to aspects of the present disclosure.

FIG. **2** is a perspective view of the load detection assembly as shown in FIG. **1**, according to aspects of the present disclosure.

FIG. **3** is a side view of the load detection assembly as shown in FIG. **1**.

FIG. **4** is a bottom view of the load detection assembly as shown in FIG. **1**, looking upward into the load detection assembly.

FIG. **5** is a partial side cross section view of the load detection assembly as shown in FIG. **1**.

FIG. **6** is a front view of the load detection assembly as shown in FIG. **1**, with the pivot arm removed.

FIG. **7** is a partial side cross section view of the load detection assembly as shown in FIG. **1**, with the sensor arm in a first sensing position.

FIG. **8** is a partial side cross section view of the load detection assembly as shown in FIG. **7**, with the sensor arm in a second sensing position.

FIG. **9** is a flowchart illustrated steps for implementing load detection using the load detection assembly of FIG. **1**.

DETAILED DESCRIPTION

Before any aspects of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other aspects and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings.

The following discussion is presented to enable a person skilled in the art to make and use embodiments of the invention. Various modifications to the illustrated embodiments will be readily apparent to those skilled in the art, and the generic principles herein can be applied to other embodiments and applications without departing from embodiments of the invention. Thus, embodiments of the invention are not intended to be limited to embodiments shown, but are to be accorded the widest scope consistent with the principles and features disclosed herein. The following detailed description is to be read with reference to the figures, in which like elements in different figures have like reference numerals. The figures, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of embodiments of the invention. Skilled artisans will recognize the examples provided herein have many useful alternatives and fall within the scope of embodiments of the invention.

It is also to be appreciated that material handling vehicles (MHVs) are designed in a variety of configurations to perform a variety of tasks. It will be apparent to those of skill in the art that the present disclosure is not limited to any specific MHV, and can also be provided with various other types of MHV configurations, including for example, order-pickers, swing reach vehicles, and any other lift vehicles. The various systems and methods disclosed herein are suitable for any of driver controlled, pedestrian controlled, remotely controlled, and autonomously controlled material handling vehicles.

FIG. **1** illustrates one non-limiting example of a material handling vehicle (MHV) **100** in the form of a counterbalanced truck according to one non-limiting example of the present disclosure. The MHV **100** can include a base **102**, a mast **104**, one or more hydraulic actuators (not shown), and a carriage **108** including a pair of forks **110** on which various loads **112** (see FIGS. **7** and **8**) can be manipulated or carried by the MHV **100**. The mast **104** can be coupled to the hydraulic actuators such that the hydraulic actuators can selectively tilt the mast **104**. The carriage **108** can be raised on the mast **104** to raise a load on the forks **110**. The carriage **108** can be coupled to the mast **104** so that when the mast **104** is tilted, the carriage **108** can be tilted, and the forks **110** can be raised. A load detection assembly **120** is shown removably coupled to the crossbars **124** and **128** of the carriage **108**.

Referring to the FIGS. **1-8**, the load detection assembly **120** comprises a housing **132** configured to couple to the crossbars **124** and **128** of the carriage **108**. In some embodiments, the housing **132** can include a top mounting portion **136** and a bottom mounting portion **140**. The top mounting portion **136** and the bottom mounting portion can be arranged to be removably mounted or coupled to the crossbars **124** and **128** of the carriage **108**.

A sensor arm **144** can be pivotally coupled to the housing **132**. The sensor arm **144** serves to contact the load when the load is being placed on the forks **110**, and the sensor arm **144** pivots toward the housing **132** as the load is moved closer to the carriage **108**. A spring **146** (best seen in FIG. **4**) can bias the sensor arm **144** outward and away from the housing **132** until a sensor arm tab **150** contacts the sensor arm stop **154** on the housing **132**. A first end of the sensor arm **144** near the spring **146** can be positioned closer to the housing **132** and/or coupled to the housing **132** than a second end of the sensor arm **144** nearest the ground that the MHV **100** rests on. In other words, the bottommost end of the sensor arm **144** can be positioned further away from the housing **132** than the topmost end. When the sensor arm tab **150** contacts the sensor arm stop **154**, the first end of the sensor arm **144** near the spring may be closer to the housing **132** than the second end of the sensor arm **144** opposite the first end. In some embodiments, the senor arm **144** can include cover layer **158** for contact with the load **112** and protection of the sensor arm **144**. The cover layer **158** can be formed from plastic, metal, rubber, or any other material suitable for repeated contact with a load. In some embodiments, the sensor arm **144** and the cover layer **158** may be made from different materials. For example, the sensor arm **144** can be made from a metal such as steel while the cover layer **158** can be made from a plastic such as high-density polyethylene (HDPE).

Within the housing **132**, one or more sensors can be mounted to a bracket **148** (best seen in FIG. **5**). In the illustrated embodiment, two sensors **152** and **156** are show as proximity sensors. It is to be appreciated that a variety of styles of sensors could be used, including one or more mechanical or electrical switches, such as snap-action, or pressure switches or strain gauges, and that more than two sensors can be used to detect more than two sensor arm positions. As best seen in FIGS. **5**, **7** and **8**, the first sensor **152** and the second sensor **156** can be mounted an equal distance away from an inside surface **145** of the sensor arm **144** or the inside of the sensor arm **144**. The sensors can be coupled to and in communication with a controller, the controller including at least one processor and one memory. The controller can be used as part of an MHV control system to detect and/or analyze signals from the sensors. The controller may also be in communication with a warehouse management system, which may be able to remotely control the material handling vehicle **100**. The controller may be coupled to a human-machine interface including a display such as a heads-up display, a liquid crystal display (LCD), an organic light emitting diode (OLED) display, a flat panel display, a solid state display, a light emitting diode (LED), an incandescent bulb, etc. The display can be used by an operator to monitor operation of the load detection assembly **120**.

The memory is computer readable media on which one or more sets of instructions, such as the software for operating the methods of the present disclosure can be embedded. The instructions may embody one or more of the methods or logic as described herein. In a particular embodiment, the instructions may reside completely, or at least partially, within any one or more of the memory, the computer readable medium, and/or within the processor during execution of the instructions.

The processor may be any suitable processing device or set of processing devices such as, but not limited to: a microprocessor, a microcontroller-based platform, a suitable integrated circuit, one or more field programmable gate arrays (FPGAs), and/or one or more application-specific integrated circuits (ASICs). The memory may be volatile memory (e.g., RAM, which can include non-volatile RAM, magnetic RAM, ferroelectric RAM, and any other suitable forms); non-volatile memory (e.g., disk memory, FLASH memory, EPROMs, EEPROMs, non-volatile solid-state memory, etc.), unalterable memory (e.g., EPROMs), read-only memory, and/or high-capacity storage devices (e.g., hard drives, solid state drives, etc.). In some examples, the memory includes multiple kinds of memory, particularly volatile memory and non-volatile memory.

The terms "non-transitory computer-readable medium" and "tangible computer-readable medium" should be understood to include a single medium or multiple media, such as a centralized or distributed database, and/or associated caches and servers that store one or more sets of instructions. The terms "non-transitory computer-readable medium" and "tangible computer-readable medium" also include any tangible medium that is capable of storing, encoding or carrying a set of instructions for execution by a processor or that cause a system to perform any one or more of the methods or operations disclosed herein. As used herein, the term "tangible computer readable medium" is expressly defined to include any type of computer readable storage device and/or storage disk and to exclude propagating signals.

Integral with or mounted to the sensor arm **144** can be two or more sensor flags extending there from, such as a first sensor flag **160** and a second sensor flag **164**. The inside of the sensor arm **144** may include the inside surface **145**, at least a portion of which may be planar. The inside surface **145** may include a portion of the surface of the sensor arm **144** that faces towards the sensors **152** and **156**. The first sensor flag **160** and the second sensor flag **164** may each radially extend away from the inside of the sensor arm **144** and/or the inside surface **145**.

In some embodiments, one or more of the sensor flags may be integral with or mounted to a portion of the sensor arm **144** other than the inside, given that the sensor flags extend away from the inside of the sensor arm **144** and towards the housing **132** and/or at least one of the sensors **152** and **156**. For example, the first sensor flag **160** could be mounted on an outside **147** of the sensor arm and extend toward the first sensor **152**.

Each sensor flag can have a neck portion and a head portion, such as neck portion **166** and head portion **168** of the first sensor flag **160**. The neck portion **166** can extend from the inside of the sensor arm **144**. The head portion **168** can extend from the end of the neck portion **166** opposite the sensor arm **144**. The head portion **168** can be optimally sized and/or shaped in order to trigger the first sensor **152**. For example, the head portion **168** can be sized to have a large enough surface area to trigger the first sensor **152**.

Each sensor flag may extend away from the inside of the of the sensor arm **144** for an activation distance, such as activation distance **170** of the first sensor flag **160**. The activation distance **170** can be the distance between the inside of the sensor arm **144** and the end of the first sensor flag **160** at the head portion **168**. Along the activation distance **170**, the head portion **168** can be wider than the neck portion **166**. The activation distances of the sensor flags can be appropriately selected to cause the sensor flags to trigger one or more of the sensors when the sensor arm **144** is pivoted various distances, as will be explained below.

Neither of the first sensor **152** or the second sensor **154** are triggered when the sensor arm **144** is pivoted fully outward as shown in FIGS. **3** and **5**. When the MHV **100** engages with the load **112**, the load depresses and pivots the sensor arm **144**, which moves the sensor flags inward and toward the two sensors **152** and **156** (see FIG. **7**). As can be best seen in FIG. **5**, the first sensor flag **160** is longer than the second sensor flag **164** (and the second sensor flag **164** is shorter than the first sensor flag **160**). Because the sensor flags are different lengths, the longer first sensor flag **160** can trigger the first sensor **152** before the shorter second sensor flag **164** can trigger the second sensor **156**.

When the first sensor **152** is triggered by the first sensor flag **160** coming into range of the first sensor **152**, a first signal can be produced that can indicate the load is in a first load position, such as, the load is seated on the forks **110** (see FIG. **7**). The first signal can be received by the MHV control system to indicate to the operator, or to the warehouse management system, for example, that the load is in the first load position. In some embodiments, the operator may be notified via the display that the load is in the first load position. In one example, when the load is in the first load position, the first signal received by the MHV control system can indicate to the operator the load is in a desired position and that the MHV can stop advancing to engage to load. In some embodiments, the operator may be notified via the display that the load is in the desired position. FIG. **7** shows the load detection assembly **120**, and specifically the sensor arm **144** in a first engagement position, and that the load **112** is in the first load position. The sensor arm **144** can pivot inward a first pivot distance corresponding to the first engagement position.

If the MHV **100** continues to travel toward the load once the first sensor **152** is triggered, the load can continue to pivot the sensor arm **144** toward the housing **132** until the second sensor **156** is triggered. When the second sensor **156** is triggered, a second signal can be produced that can indicate that the load is in a second load position, such as, the load is fully seated on the forks **110**. The second signal can be received by the MHV control system to indicate to the operator, or warehouse management system, for example, that the load is in the second load position and/or that the load is ready to be lifted, moved, or otherwise handled. In some embodiments, the operator may be notified via the display that the load is ready to be lifted, moved, or otherwise handled. In one example, when the load is in the second load position, the second signal received by the MHV control system can indicate to the operator the load has been fully seated on the forks **110** and that the MHV can stop advancing to engage to load. In some embodiments, the operator may be notified via the display that the load has been fully seated on the forks **110** and that the MHV can stop advancing to engage to load. The second signal can be used to indicate that the load is being pushed on the floor, and to signal the MHV to stop advancing. FIG. **8** shows the load detection assembly **120**, and specifically the sensor arm **144** in a second engagement position, and that the load **112** is in the second load position. The sensor arm **144** can pivot inward a second pivot distance associated with the second engagement position. The first pivot distance may be shorter than the second pivot distance.

The load detection assembly **120** can provide unique features of being able to have two or more dedicated sensing ranges. By changing which sensors and sensor flags are installed into the load detection assembly **120**, it is possible to add or remove sensing features based on MHV option codes and customer requests. By varying the length or number of the sensors and sensor flags, the sensing ranges can also be fine-tuned.

The neck portion and/or head portion of the sensor flags may be adjustable in order to allow the operator to change the sensing ranges of the load detection assembly **120**. For example, the neck portion **166** can include a number of telescoping portions that allow the operator to lengthen or shorten the activation distance **170** of the first sensor flag **160**. If the operator lengthens the activation distance **170**, the first pivot distance corresponding to the first engagement position is shortened. In turn, the first load position corresponding to the first engagement position will be sensed when the load **112** is further away from the vertical portion of the forks **110** than the previous arrangement. Conversely, if the operator shortens the activation distance **170**, the first pivot distance corresponding to the first engagement position is lengthened, and the first load position corresponding to the first engagement position will be sensed when the load **112** is closer to the vertical portion of the forks **110** than the previous arrangement.

The operator may lengthen the activation distance **170** of the first sensor flag **160** in order to sense the load **112** sooner or that the load **112** is further away from the vertical portion of the forks **110** as compared to the previous arrangement. The operator may shorten the activation distance **170** to allow the load detection assembly **120** to sense that the load **112** is closer to the vertical portion of the forks **110** or make sure the load **112** is better seated on the forks **110** for moving or handling. The operator may lengthen the activation distance of the second sensor flag **164** in order to have the load **112** be seated further away from the vertical portion of the forks **110**, which may be desirable for moving or handling certain types of loads. The operator may shorten the activation distance of the second sensor flag **164** in order to have the load **112** be seated closer to the vertical portion of the forks **110**, which may be desirable for moving or handling certain types of loads.

In some embodiments, the sensors **152** and **156** can be adjustable in order to allow the operator to change the sensing ranges of the load detection assembly **120**. Adjusting a sensor to be positioned further away from the sensor arm **144** and/or the corresponding sensor flag may have the same effect on a sensing range of the load detection assembly **120** as shortening the activation distance of the corresponding sensor as described above. Conversely, adjusting a sensor to be positioned closer to the sensor arm **144** and/or the corresponding sensor flag may have the same effect on a sensing range of the load detection assembly **120** as lengthening the activation distance of the corresponding sensor as described above.

As seen in FIG. **3**, the sensor arm **144** may have an adjustment block **155** for adjusting multiple sensing ranges of the load detection assembly **129**. The adjustment block **155** can be removably coupled to the outside **147** of the sensor arm **144** and extend away from the outside **147** in order to shorten the first pivot distance and/or second pivot distance of the sensor arm **144**. The adjustment block **155** may be in contact with at least a portion of the outside **147**, such as the entire outside **147** or a portion of the outside **147** near the end of the sensor arm **144** opposite the spring **146**. The operator may install the adjustment block **155** in order to have the load **112** be better seated on the forks **110** for handling, such as if the load **112** would be better seated towards the middle of the forks **110**. For example, if the MHV is programmed indicate a load is ready to be lifted and/or moved after receiving a signal from the second sensor **156**, the operator may select an adjustment block **155** of an appropriate size to cause the second sensor **156** to be activated by the second sensor flag **164** when the load **112** is positioned most optimally for handling on the forks **110**. Installing the adjustment block **155** may have the same effect on the sensing ranges of the load detection assembly as lengthening all sensor arms and/or moving all sensors towards the sensor arm **144** and/or the corresponding sensor flag as described above. The adjustment block **155** may have the same thickness as the portion of the sensor arm without the sensor plate.

Referring to FIGS. **1-8** as well as FIG. **9**, an exemplary embodiment of process **900** for implementing a load detection system in a material handling vehicle is shown. The process **900** can be implemented as instructions on a memory of a computational device such as a controller coupled to and in communication with the first sensor **152** and the second sensor **156** as described above.

At **904**, the process **900** can receive a first signal from the first sensor **152** coupled to the material handling vehicle **100**. The first signal may be one of a plurality of values if the first sensor **152** is a polychotomous sensor such as a proximity sensor. The first signal may be a discrete value such as on or off if the first sensor **152** is a certain sensor type such as a contact switch. The process **900** can then proceed to **908**.

At **908**, the process **900** can determine that the load **112** is in the first load position. In some embodiments, the load **112** can be in a desired position for lifting the forks **110** and/or load **112** if the first load position has been selected to be the optimal position for lifting the load **112**, i.e., that the load **112** is fully seated on the forks **110**. In other embodiments, the load **112** can be in a desired position for lifting the forks **110** and/or load **112** if the second load position has been selected to be the optimal position for lifting the load **112**, i.e., that the load **112** is fully seated on the forks **110**. The process **900** can then proceed to **912**.

At **912**, the process **900** can indicate to at least one of the operator or the warehouse management system that the load **112** is in the first load position and/or seated on the forks **110**. In some embodiments, the process **900** can indicate to the operator that the load **112** is in the first load position and/or seated on the forks **110** using an interface coupled to the material handling vehicle **100**. The interface may be a display such as a heads-up display, a liquid crystal display (LCD), an organic light emitting diode (OLED) display, a flat panel display, a solid state display, a light emitting diode (LED), or an incandescent bulb. In some embodiments, the process **900** can indicate to the warehouse management system over a warehouse communication network such as a WiFi network that the load **112** is in the first load position and/or seated on the forks **110**.

If the first load position has been selected to be the optimal position for lifting the load **112**, at **940** the process **900** can indicate to the material handling vehicle **100** to cease advancing towards the load **112**. For example, the process **900** may cause a system of the material handling vehicle **100** to brake and stop forward progress towards the load **112**. The process **900** can then proceed to **944**.

At **944**, the process **900** can receive a command to raise the forks **110** a vertical distance from one of the operator or the warehouse management system. The command can be received from the operator via an input on the interface if the interface is capable of receiving inputs, such as a touch screen flat panel display. Alternatively, the command can be received from a keypad, button, switch, knob, dial, or other electromechanical input device. The command can be received from the warehouse management system over a warehouse communication network such as a WiFi network. The process **900** can then proceed to **948**.

At **948**, the process can cause the forks **110** to be raised the vertical distance. In some embodiments, the process **900** can control one or more hydraulic actuators to raise the forks **110**. The forks **110** can in turn lift the load **112** as long as the load is in the first load position.

If the second load position has been selected to be the optimal position for lifting the load **112**, the process **900** can instead proceed to **916**.

At **916**, the process **900** can receive a second signal from the second sensor **156** coupled to the material handling vehicle **100**. The second signal may be one of a plurality of values if the second sensor **156** is a polychotomous sensor such as a proximity sensor. The second signal may be a discrete value such as on or off if the second sensor **156** is a certain sensor type such as a contact switch. The process **900** can then proceed to **920**.

At **920**, the process **900** can determine that the load **112** is in the second load position. Depending on the setup of the load detection assembly **120**, the **900** process can then determine that the load **112** is fully seated on the forks **110** if the second load position has been selected to be the optimal position for lifting the load **112**, i.e., that the load **112** is fully seated on the forks **110**. The process **900** can then proceed to **924**.

At **924**, the process **900** can indicate to at least one of the operator or the warehouse management system that the load **112** is in the second load position, in an optimal position for lifting, and/or fully seated on the forks **110** or that the material handling vehicle **100** can stop advancing towards the load **112**. In some embodiments, the process **900** can indicate to the operator that the load **112** is in the second load position, in an optimal position for lifting, and/or fully seated on the forks **110** or that the material handling vehicle **100** can stop advancing towards the load **112** using an interface coupled to the material handling vehicle **100**. The interface may be a display such as a heads-up display, a liquid crystal display (LCD), an organic light emitting diode (OLED) display, a flat panel display, a solid state display, a light emitting diode (LED), or an incandescent bulb. In some embodiments, the process **900** can indicate to the warehouse management system over a warehouse communication network such as a WiFi network that the load **112** is in the second load position, in an optimal position for lifting, and/or fully seated on the forks **110** or that the material handling vehicle **100** can stop advancing towards the load **112**. The process **900** can then proceed to **928**.

At **928**, the process **900** can indicate to the material handling vehicle **100** to cease advancing towards the load **112**. For example, the process **900** may cause a system of the material handling vehicle **100** to brake and stop forward progress towards the load **112**. The process **900** can then proceed to **932**.

At **932**, the process **900** can receive a command to raise the forks **110** a vertical distance from one of the operator or the warehouse management system. The command can be received from the operator via an input on the interface if the interface is capable of receiving inputs, such as a touch screen flat panel display. Alternatively, the command can be received from a keypad, button, switch, knob, dial, or other electromechanical input device. The command can be received from the warehouse management system over a warehouse communication network such as a WiFi network. The process **900** can then proceed to **936**.

At **936**, the process can cause the forks **110** to be raised the vertical distance. In some embodiments, the process **900** can control one or more hydraulic actuators to raise the forks **110**. The forks **110** can in turn lift the load **112** as long as the load is in the second load position.

While various spatial and directional terms, such as top, bottom, lower, mid, lateral, horizontal, vertical, front, and the like may be used to describe examples of the present disclosure, it is understood that such terms are merely used with respect to the orientations shown in the drawings. The orientations may be inverted, rotated, or otherwise changed, such that an upper portion is a lower portion, and vice versa, horizontal becomes vertical, and the like.

Within this specification, embodiments have been described in a way which enables a clear and concise specification to be written, but it is intended and will be appreciated that embodiments may be variously combined or separated without parting from the invention. For example, it will be appreciated that all preferred features described herein are applicable to all aspects of the invention described herein.

Thus, while the invention has been described in connection with particular embodiments and examples, the invention is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto. The entire disclosure of each patent and publication cited herein is incorporated by reference, as if each such patent or publication were individually incorporated by reference herein.

Various features and advantages of the invention are set forth in the following claims.

We claim:

1. A system for detecting a position of a load on at least one fork of a material handling vehicle, the system comprising:

a housing coupled to a carriage of the material handling vehicle, and the at least one fork coupled to the carriage;

a first sensor positioned within the housing;

a second sensor positioned within the housing;

a sensor arm pivotally coupled to the housing;

a first sensor flag extending from the sensor arm for a first activation distance;

a second sensor flag extending from the sensor arm for a second activation distance;

wherein the sensor arm is configured to pivot a first distance inward toward the housing and the carriage and cause the first sensor flag to trigger the first sensor to indicate a first load position; and

wherein the sensor arm is further configured to pivot a second distance inward toward the housing and the carriage and cause the second sensor flag to trigger the second sensor to indicate a second load position.

2. The system of claim **1**, wherein the first activation distance is greater than the second activation distance.

3. The system of claim **1**, further comprising a controller coupled to the first sensor and the second sensor, the controller configured to:

receive a signal from the second sensor;

determine that the load is in the second load position; and indicate to at least one of an operator or a warehouse management system the position of the load.

4. The system of claim **1**, wherein the first sensor and the second sensor are proximity sensors.

5. The system of claim **1**, wherein the first sensor flag extends away from an inside of the sensor arm for the first activation distance and the second sensor flag extends away from the inside of the sensor arm for the second activation distance, the first activation distance being greater than the second activation distance.

6. The system of claim **5**, wherein the first sensor flag is adjustable to adjust the first activation distance between a plurality of lengths; and

the second sensor flag is adjustable to adjust the second activation distance between a plurality of lengths.

7. The system of claim **1**, further comprising a spring configured to bias the sensor arm outward from the housing.

8. The system of claim **7**, wherein in a first position, a first end of the sensor arm nearest to the spring is positioned closer to the housing than a second end of the sensor arm opposite the first end and nearest to the ground that the material handling vehicle rests on.

9. The system of claim **1**, further comprising a sensor arm tab extending from the sensor arm, and wherein the housing comprises a sensor arm stop configured to prevent the sensor arm from pivoting outward away from the housing when the sensor arm tab is in contact with the sensor arm stop.

10. The system of claim **1**, wherein the first sensor flag extends away from the inside of the sensor arm for the first activation distance and comprises a neck portion extending from a first end at the inside of the sensor arm and a head portion extending from a second end of the neck portion opposite the first end, the head portion being wider along the first activation length than the neck portion.

11. The system of claim **10**, wherein the head portion is sized to activate the first sensor.

12. The system of claim **1**, wherein the sensor arm comprises a cover layer configured to contact the load, the cover layer being a material different than the sensor arm.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 11,274,021 B2
APPLICATION NO. : 16/377858
DATED : March 15, 2022
INVENTOR(S) : Adam Wayne Standard et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

Item (54) and in the Specification, Column 1, Line 2, "MEIHODS" should be --METHODS--.

Signed and Sealed this
Twenty-fourth Day of May, 2022

Katherine Kelly Vidal

Katherine Kelly Vidal
Director of the United States Patent and Trademark Office